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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/772,280	02/06/2004	Masahiro Koike	248684US2SRD	4940
22850	7590	06/16/2005	EXAMINER	
OBLON, SPIVAK, MCCLELLAND, MAIER & NEUSTADT, P.C.			HO, TU TU V	
1940 DUKE STREET			ART UNIT	
ALEXANDRIA, VA 22314			PAPER NUMBER	

2818

DATE MAILED: 06/16/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

AK

<b>Office Action Summary</b>	<b>Application No.</b> 10/772,280	<b>Applicant(s)</b> KOIKE ET AL.	
	<b>Examiner</b> Tu-Tu Ho	<b>Art Unit</b> 2818	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 25 May 2005.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-23 is/are pending in the application.
- 4a) Of the above claim(s) 13-20 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-12 and 21-23 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 06 February 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All    b) ☐ Some \*    c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |   |   |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)   | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948)   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## **DETAILED ACTION**

### ***Oath/Declaration***

1. The oath/declaration filed on 02/06/2004 is acceptable.

### ***Election/ Restriction***

2. Applicant's election of Invention I, claims 1-12 and 21-23, in the reply filed on 05/25/2005 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)). Specifically, the traversal is on the ground(s) that a search and examination of the entire application does not pose a serious burden. This is not found persuasive because, as indicated in the Restriction Requirement, the different inventions are in different classifications, thus a search in the different classifications poses a serious burden on the examiner.

The requirement is still deemed proper and is therefore made FINAL.

3. Claims 13-20 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement as noted above.

### ***Claim Rejections - 35 USC § 103***

Art Unit: 2818

The following is a quotation of 35 U.S.C. §103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. **Claims 1-12 and 21-23** are rejected under 35 U.S.C. §103(a) as being unpatentable over Pomarede et al. U.S. Patent Application Publication 20040147101 (the '101 reference) or as being unpatentable over Pomarede et al. U.S. Patent Application Publication 20040147101 (the '101 reference) in view of Koyama et al. U.S. Patent Application Publication 20020149065 (the '065 reference).

Referring to **claims 1, 7-8, and 21**, the '101 reference teaches a semiconductor device comprising a substrate (200, Fig. 4) including a channel region (not shown but inherent for the device to function) ; an insulating film (260) formed above the substrate and containing a metal, Si, N, and O [(the base materials, HfO<sub>2</sub>, representing the metal and the O of the claim, are formed by deposition step 120 – paragraph [0068] and Fig. 3, the Si is formed by the treatment step 110 – paragraph [0066] – which is represented as Si-N bonds, the N is formed under an excited state by the treatment step 110 and step 125 – paragraphs [0066] and [0084]-[0085] – which is represented as metal-nitrogen bonds, which “nitrogen” is the same as the N of the claim)]; a gate electrode (220) formed above the insulating film (also called a gate insulating film in the art and by claim 7), and a pair of source/drain (also called impurity diffusion regions in the art and by claim 7) that is inherent for the device to function but not shown sandwiching the not-shown channel region.

However, the reference fails to teach that the insulating film that includes metal, Si, N, and O contains metal-N bonds larger than the sum total of metal-metal bonds and metal-Si bonds

Art Unit: 2818

as recited in claim 1, thus also fails to disclose a spectrum peak at a bonding energy of a metal-N bond as recited in claim 21. Nevertheless, as noted above, the reference teaches introducing the N under an excited state and forming Si-N and metal-N bonds in the process.

The '065 reference, also in disclosing a semiconductor device including a substrate/insulating film/gate electrode, teaches that the insulating film that includes a metal oxide ( $\text{ZrO}_2$ ) when treated by N under an excited state will include metal-N bonds ("zirconium-nitrogen bonds", Figs. 2-3 and paragraphs [0067] and [0068]), and further teaches in Fig. 3 that the insulating film includes metal-N bonds and metal-O bonds.

Therefore, per the teachings of the '065 reference, the '101 reference's insulating film that includes metal, Si, N, and O contains, wherein the N is introduced under an excited state as taught by both the references, will include metal-N bonds, together with the metal-O bonds. Furthermore, since both the references are silent as to the metal-metal bonds and the metal-Si bonds, it is reasonable to conclude that the metal-metal bonds and the metal-Si bonds, as evident from Fig. 3 of the '065 reference, which are invariably formed in the process, are small compared to the metal-N bonds. Therefore, it is reasonable to conclude that the insulating film that includes metal, Si, N, and O contains metal-N bonds larger than the sum total of metal-metal bonds and metal-Si bonds as recited in claim 1, thus also will have a spectrum peak at a bonding energy of a metal-N bond as recited in claim 21.

Referring to the limitation "being amorphous" in "the insulating film being amorphous" of **claim 8**, the '101 is silent about the crystal state of the insulating film. However, the '065 reference teaches that the insulating film must remain amorphous in order to improve the yield of the device (paragraph [0008]). Therefore, it would have been obvious to one of ordinary skill in

Art Unit: 2818

the art at the time the invention was made to form the '101 reference's insulating film such that it remains amorphous. One would have been motivated to make such a change because the '065 teaches that the insulating film must remain amorphous in order to improve the yield of the device.

Referring to **claims 2 and 9**, although both of the references are silent about the atomic percentage of the metal-N bonds, it is within the ability of an artisan of ordinary skill, therefore would have been obvious, to form the device such that a content of the metal-N bonds in the insulating film is 1 atomic% or more.

Referring to **claim 3**, as evident from the teachings of the '101 reference, the bulk of the insulating film is the metal oxide of the layer 260, and the Si of the insulating film is from the treatment step 110, which Si is from the underlying semiconductor silicon layer, therefore it appears that the insulating film contains more metal and less Si and consequently an insulating film containing more metal and less Si meets the limitation that a content of the metal in the insulating film is 47 atomic% or more based on the total amount of the metal and Si..

Referring to **claims 4 and 10**, the metal of the '101 reference is Hf (from  $\text{HfO}_2$ ), meets the limitation of the claimed Markush group.

Referring to **claims 5 and 11**, as noted above, the metal of the '101 reference is Hf, and the insulating film contains Si-N bonds (paragraph [0066], Hf-O bonds (from  $\text{HfO}_2$ ), and Hf-N bonds (paragraph [0085], "metal-nitrogen bonds", where metal is Hf). Compared to the claims, the reference appears to lack Si-O bonds. However, the reference teaches forming the  $\text{HfO}_2$  layer on the Si (silicon) semiconductor layer ("deposition 120", paragraph [0068]). It appears that the O of the  $\text{HfO}_2$  will react with the underlying silicon to form the claimed Si-O bonds.

Referring to **claims 6 and 12**, the insulating film thus detailed above for claims 5 and 11 could be represent by the formula described in the claims.

Referring to **claim 22**, the '101 reference does not disclose a metal-metal bond for the insulating film, therefore the insulating film has no spectrum peak at a bonding energy of a metal-metal bond.

Referring to **claim 23**, as noted above for claims 5 and 11, the '101 reference discloses Si-N bonds, metal-O bonds (Hf-O bonds, from  $\text{HfO}_2$ ), and Hf-N bonds, and appears to disclose Si-O bonds. The reference further discloses no other bonds. Therefore, the reference discloses that the insulating film has other spectrum peaks at binding energies of a metal-O bond, a Si-N bond, that the insulating film appears to have another spectrum peak at binding energy of Si-O bond, and that the insulating film has no other spectrum peak(s) at a binding energy.

### *Conclusion*

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tu-Tu Ho whose telephone number is (571) 272-1778. The examiner can normally be reached on 6:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, DAVID NELMS can be reached on (571) 272-1787. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished

Art Unit: 2818

applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Tu-Tu Ho  
June 12, 2005



DOCKET NO.: 248684US2SRD

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

IN RE APPLICATION OF: Masahiro KOIKE, et al.

SERIAL NO: New Application

FILED: HEREWITH

FOR: SEMICONDUCTOR DEVICE AND METHOD OF MANUFACTURING  
SEMICONDUCTOR DEVICE

**STATEMENT OF RELEVANCY**

**Reference AW on Form PTO 1449:**

This reference relates to HfSiON films. Their films contain Hf/(Hf+Si) of less than 47%. But, this reference doesn't mention about Hf-N bonds. Due to the low Hf concentrations in the films, their films don't include Hf-N bonds.

Our HfSiON films contain Hf/(Hf+Si) of more than 47% and include a large amount of Hf-N bonds which enhance the dielectric constant up to 24 in HfSiON with Hf/(Hf+Si) of 80% and N of 35%.

Noted  
TH  
04/05

**LIST OF RELATED CASES**

<u>Docket Number</u>	<u>Serial or Patent Number</u>	<u>Filing or Issue Date</u>	<u>Inventor/ Applicant</u>
246244US2 SRD	10/726,606	12/04/03	KOYAMA et al.

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